Molecular Systematics of *Ganoderma:* What Is Reishi?

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Ganoderma is a very distinctive genus of white-rot polypore fungi that is primarily characterized by the formation of a double-walled, generally echinulate basidiospore. Most *Ganoderma* species are very variable macromorphologically and lack micromorphological distinctiveness. As a consequence, earlier taxonomic studies in the genus have created many synonymous names and have resulted in largely ambiguous species delimitation and identification systems, making species identification in the genus virtually impossible. *Ganoderma* strains used in oriental folk medicine refer to Reishi and have traditionally been labeled *Ganoderma lucidum* (W.Curt.: Fr.) P. Karst. in the scientific literature. However, there is now accumulative evidence that most species reported as *G. lucidum* in most of the pharmacological and phytopathological studies were wrongly identified.

G. lucidum was first described as *Boletus lucidus* by William Curtis in 1781 from a filbert plant (= *Corylus avellana*) in London, UK. Curtis's original collection (i.e., the type specimen) has been lost. The actual type is represented in a color plate, which is in agreement with the International Code of Botanical Nomenclature. However, the typified plate is of no use for providing cultural characteristics and genetic information that would be useful for distinguishing *G. lucidum* from the other British laccate *Ganoderma*.

Over the years, at least 166 laccate *Ganoderma* species have been described worldwide, of which at least 48 names were, at some point, considered to be synonyms of others. There is nevertheless a strong consensus about the true identity of *G. lucidum* among contemporary European mycologists. Molecular phylogenetic studies indicate that *Ganoderma* is a young genus in agreement with earlier morphological evidence as pointed out by the Norwegian mycologist Leif Ryvarden. DNA studies have shown that the *G. lucidum* species complex is composed of several species that can be difficult to distinguish from one another. These species include the European *G. valesiacum* Boud.; *G. ahamdii* Stey., described from Pakistan; North American *G. tsugae* Murrill and *G.oregonense* Murrill; and other taxa variously labeled *G. resinaceum* Boud., *G. oerstedii* Fr., and *G. praelongum* Murrill.

Recent genetic and biogeographic studies have indicated that most *Ganoderma* species are geographically restricted. *G. lucidum* is probably restricted to western parts of Europe, although its distribution range can possibly also include parts of Siberia and of north western regions of China. Based on molecular phylogenetic evidence, it appears that most collections labeled *G. lucidum* in North America do in fact best correspond to the taxon labeled *G. resinaceum* in Europe, whereas *G. tsugae* in North America is genetically very close to the "true" *G. lucidum* from Europe.

This leads to the question of what is the Oriental Reishi? A nonexhaustive molecular survey of taxa labeled *G. lucidum* in Asia, including strains com-

mercially cultivated for the production of health tablets or teas, shows that this name has been largely misapplied and encompasses many distinct species.

Incorrect taxonomic identification of *Ganoderma* strains hampers comprehensive strategies for drug discovery as well as for monitoring and managing diseases caused by *Ganoderma* in woody crops and forest ecosystems. Both molecular phylogenies and morphological evidence indicate that Africa probably harbors the highest genetic and taxonomic diversity in the genus.